A MORPHOLOGICAL AND GENETIC STUDY OF CERTAIN WEST FLORIDA SOILS

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INTRODUCTION

Soils develop from various parent materials. The five factors of soil genesis - climate, organisms, relief, parent material, and time - are interdependent and modify each other to produce the final soil. Living organisms and the effects of climate - temperature and rainfall - act on and alter the parent material. The intensity of their action is modified by the relief of the area. The effects of the active factors are accentuated by the length of time they operate.

In the humid climates, two soil forming processes are dominant on the upland soils. Podzolization occurs more frequently in the cooler regions under forest vegetation. These conditions allow for the formation of a peaty mat on the surface and the soil becomes very acid and low in bases. Clays, iron, and alumina compounds are carried down from the upper to the lower layers causing a whitening of the horizon beneath the peaty mat. Laterization is more dominant in the warmer regions. Under this process some of the silica of rocks and minerals is hydrolyzed to silicic acid which is leached more rapidly than are the compounds of iron and alumina. These latter compounds are often dehydrated and form lateritic materials which are mostly only slightly acid and generally have low cation exchange capacities.

Florida is located in the humid region north of the areas where the laterization process is dominant and south of the areas where podzolization is dominant. It is possible,therefore, that an area of transition between these two processes may occur in some portion of the state, although there is very little work to substantiate this. Also, soil

development of the finer-textured, well-drained soils of West Florida has not been studied extensively, and basic information concerning the genesis and morphology of these soils is needed to aid in their classification and use. Therefore, certain selected profiles of soils belonging to the Marlboro, Faceville, Magnolia, and Greenville series were chosen from Gadsden, Jackson, and Washington counties. These soils are quite extensive in area, have ample amounts of clay in their horizons, and are important to agriculture.

LITERATURE REVIEW

Geology of West Florida

Fenneman characterized the area of West Florida as being within the East Gulf Coastal Plain Section which he describes as a young to mature belted coastal plain (29). More specifically he reported the area as occurring in the southern ends of the Tifton Upland and a Lime Sink district which is similar and adjacent to the Dougherty Plain (28). The Tifton Upland is described as a Miocene formation which weathers to produce a sandy soil of gray to yellowish color clearly distinguishable from the red soils forming from the Eocene formation. The topography of the Tifton Upland consists of "gently rolling hills with broad rounded summits, relief being less than 50 feet," while the Lime Sink region is described as having a nearly level surface (28).

Cooke (21) and other authors mentioned that the action of ancient seas formed terraces on the topography of the area. He also stated that four natural topographic regions occur in West Florida: the Western Highlands which is hilly in the northern part and is a broad, gently rolling upland in the southern part; the Marianna Lowlands which have low-rolling hills and hollows dotted with sinks; the Tallahassee Hills which have "long gentle slopes with rounded summits;" and the Coastal Lowlands.

The formations occurring in West Florida are listed in Cooke's work as revised by Vernon (22a). The formations covering the greater part of the area are the Hawthorn consisting of "interbedded sand, clay, marl, and limestone with lenses of Fuller's earth;" the Citronelle of

sand, gravel, and clay; the Flint River of sandy and pebbly limestone and calcareous discolored sand; and the lower marine and estuarine terrace deposits of the Coastal Lowlands.

The sites from which soil profile samples were obtained were located in the uplands on nearly level to slightly rolling topography in the Florida counties of Gadsden, Jackson, and Washington. The weathered surface materials were generally sandy and ranged from yellow to reddish-brown in color. Cooke, Vernon, and Puri (22b) listed the Alum Bluff formation (Hawthorn) and other Miocene facies, Oligocene formations (Suwannee limestone, Byram Marl, and Marianna Limestone) and Eocene formations (Crystal River, Williston, and Inglis) as occurring in the study area. Moore's publication (54) indicated that the Tampa formation, Crystal River limestone, and the Suwannee limestone underlie areas of Jackson County, and Vernon (74) indicated that Marianna limestone underlies the northeast portion of Washington county; however, all of the parent materials of the soils used in the study were identified as being of the Hawthorn formation and described as noncalcareous, nonphosphatic materials (32). White, and in some cases yellow, mottles appeared in the lower depths of the profiles. Vernon (75) characterized the Hawthorn formation as "deltaic having erosional unconformities at top and bottom." Puri (59) described the Hawthorn formation as "sand, argillaceous, calcareous, yellow, gray, and white variegated, cross bedded, and thinly laminated in places," and stated that this material fanned out resulting in a formation of variable thickness.

Red and Yellow Soils

The Red and Yellow Soils of the Southeastern United States and the factors surrounding them are described by Joffe (42). He stated that due to the tendency for the intermediate products of decomposition, such as organic acids and other solutions, to persist and due to the strong leaching and dormant growing season, the effects of laterization is not strongly pronounced and the process of podzolization is allowed to be superimposed on the laterization process. He indicated that the majority of these soils are slightly to strongly acid and the quantity of bases are very small, and adds that there is a definite shift of silica while the accumulation of sesquioxides is not as much as expected.

Dambermire (23) stated that when laterization has removed all the bases by leaching and the light-colored A and dark-colored B horizon form a solum 1 to 1.5 meters deep, laterization passes into podzolization. He further stated that the Red and Yellow Podzolic Soils of the Southeastern United States were originally laterized in the early stages of development; then became definitely podzolized.

Marbut (50) stated that after the laterization process is complete and has removed the silica, alkalies, and alkaline earths, the process of podzolization continues and removes some of the concentrated iron and aluminum.

Anderson and Byers (3) stated that Jurney described a red soil of North Carolina as having an A horizon of clay loam slightly reddish-brown in color, a B_1 of heavy brittle clay deep red in color, a B_2 of crumbly

clay light red in color, and a C horizon occurring below 60 inches as consisting of decomposed diorite of ochreous yellow, black, and reddish-brown in color. The pH decreased from 6.3 in the A horizon to 4.1 in the C horizon; organic matter also decreased with increasing depth. The silica-sesquioxide ratios in the colloidal clay was stated as being 1.46 for the A horizon, 1.49 for the B_1 horizon, 1.42 for the B_2 horizon, and 1.40 for the C horizon.

Robinson (61) described a red loam profile as having a deep and uniform layer of fairly plastic clay with the lower horizon often having yellow mottlings, then a gradual change to the parent material. He summarized the Yellow Earths as occurring mostly in the subtropics and the warm temperate climates forming a transition between the tropical Red Soils and the Brown Forest Soils of the temperate climates. The yellow color of the soils is due to the higher degree of hydration of the ferric oxide than in the red soils. Robinson further stated that there is a possibility that the Yellow Soils may also have resulted from incipient podzolization of Red Soils, or may represent early stages in the development of Red Soils. Another possibility is that the Yellow Soils may have been formed from the weathering of parent materials low in iron.

Robinson (61) wrote that Marbut believed the yellow color of such soils as the Norfolk to be due to iron removal during an earlier stage of impeded or sluggish drainage and in this way differ from the adjacent Red Soils.

Millar and Turk (52) wrote that the Red and Yellow Soils occur in regions where high temperatures along with heavy rainfall accelerate

mineral decay in the area generally to the south of the Gray-Brown Forest Soils. Increased also is the leaching of soluble products as well as the decay of organic matter. These soils have a low accumulation of surface organic matter, a deep horizon of eluviation and a deep, thick, illuviated horizon in which the high rate of oxidation and hydration of iron produces bright red and yellow colors. At the southern boundary of these soils there is evidence in many places that the present soils were derived from old profiles which developed under a more tropical climate than the existing one.

Grim (31) described the conditions surrounding and the mechanism by which the Red and Yellow Soils were formed. The vegetation is either mixed or largely deciduous, rainfall is abundant, and a warm, mild climate prevails. There is marked leaching and the silicate breakdown is small; however, there is some translocation of colloidal silicates. Relatively rapid oxidation takes place causing the iron to be checked in its downward movement, resulting in the iron remaining in the upper part of the profile.

Simonson (65) indicated that the dominant processes in the Red-Yellow Podzolic Soils are the formation of silicate clay minerals at great depth and their subsequent destruction and gradual disappearance in the solum.

The type of clay found to be most abundant in the Red-Yellow Soils is kaolin. Nyun and McCaleb (55) reported considerable kaolinite and halloysite clays present in the Davidson and Hiwassee soil profiles of North Carolina. Dyal <u>et al.</u> (27) reported large amounts of kaolin in

the clays of a Ruston soil in Georgia. Coleman and Jackson (20) reported that kaolin was dominant in the clays of the Orangeburg B and C horizons. Rich and Obenshain (60) found mainly kaolinite, vermiculite and interstratified illite-vermiculite in the clay fractions of Nason silt loam. Illite, gibbsite, kaolinite, and some montmorillonite, vermiculite, and quartz were reported for a number of West Florida soils (30).

Lyon and Buckman (46) stated that the Red and Yellow Podzolic Soils are being increasingly modified by the influence of laterization.

The Red and Yellow Soils of the Southeastern United States are also described as soils in which the laterization process, although incomplete, is markedly evident with most having been modified by podzolization. The SiO_2/Al_2O_3 ratio of the colloidal fraction is approximately 2 (18).

The Red-Yellow Podzolic Soils were also included in the Latosolic soils on the basis that these soils have some of the features of each of podzolic and lateritic groups, being more closely related to the latosolic group, yet having a distinct A_2 (66). Marbut (50) drew a tentative imaginary line extending from the southeast corner of South Carolina to the vicinity of Mobile, Alabama. He described the soils south of the line as "lateritic" although "not laterites," and the soils north of the line as being predominantly podzolic. Latosolic weathering is said to extend as far north as 34°N latitude in Alabama (49). Strongly lateritic soils have been shown to occur in Cuba (7) and Northern Venezuela (38). True podzols, on the other hand, are found to occur in the northern portions of some of the Lake States(42,52).

Thorp and Smith (69) included the Red and Yellow Podzolic Great Soil Group under the suborder Light-Colored Podzolic Soils, while the Great Soil Group of Reddish-Brown Lateritic Soils is listed under the suborder of Lateritic Soils. The soils of West Florida are also listed as being in an area dominated by Red and Yellow Podzolic Soils (Lateritic Materials) (70, 52).

The soils under study are classified in the Soil Series Descriptions of the National Cooperative Soil Survey (26) as follows: Marlboro as a Yellow Podzol, Faceville as a Red-Yellow Podzol, Magnolia as a Red Podzol, and Greenville as a Reddish-Brown Latosol. Another reference (4) lists the Magnolia and Greenville soils as members of the Red Podzolic Great Soil Group which is a member of the Lateritic Soils Suborder. The Faceville, Magnolia, and Greenville series are also sometimes found included in the red loams of the Lateritic Soils (42).

SiO_2/Al_2O_3 and SiO_2/R_2O_3 Ratios

Holmes et al. (34) arranged the Norfolk, Ruston, and Orangeburg in order from the less well drained to the better drained soil and indicated that, in general, the silica-sesquioxide ratios of their surface colloids decreased in the same order. The changes in the composition of the colloids of these soils are the result of the differences in the present active soil-forming processes. The Orangeburg profile, having a low silica-sesquioxide ratio in the first two horizons, was indicative of a highly laterized soil in which more silicates than sesquioxides had been broken down and removed by solution; and the C horizon having a larger silica-sesquioxide ratio indicated the colloids of the deeper Orangeburg

soil had not been altered to the same extent as those in the upper horizons. The silica-sesquioxide ratios for the colloids of the other soil profiles were slightly lower in the B horizon than in the A horizon, indicating incipient podzolization is slightly greater in less well drained soils. The same general trend was found for the silica-alumina ratios.

The SiO_2/Al_2O_3 ratio was introduced by Martin and Doyne (51) for identifying true laterites. They regarded soils having a ratio of 1.33 or less as lateritic. They later modified their earlier SiO_2/Al_2O_3 ratio limit to 2.2 or 2.3. Mohr and Van Baren (53) also used this ratio and suggested it as representing a trend in relating climate to soil development. They reported that Joachim considered soils having a SiO_2/Al_2O_3 ratio of the clay fraction between 1.33 and 2.0 to be lateritic red earths, and those having a ratio larger than 2.0 as non-lateritic red loams or immature lateritic soils.

Joffe (42) stated that the SiO_2/Al_2O_3 ratio, known also as the "ki" value of Harrassowitz and the "sa" value of Marbut, is a useful index for the determination of the degree of laterization, and he considered soils having a ratio between 1.0 and 2.0 as lateritic, and those having a ratio below 1.0 as a genuine laterite. This index was also used by a number of other workers (41, 47).

Jenny (39) indicated that the SiO_2/Al_2O_3 ratio for the pedsols of the north may be 3 to 4 or even higher and this ratio for the Red Soils of the Southeastern United States as being less than 2.0. He also stated that this ratio seems to fit better for detailed analyses of the laterites than the SiO_2/R_2O_3 ratio and feels that the inclusion of

iron gave a constant that is less clear-cut; however, a number of workers (3, 41) still prefer the use of the SiO_2/R_2O_3 ratio.

The meaning of the SiO_2/Al_2O_3 ratio has met with some disagreement. The main objections were that the ratio was either too limited (62), or the importance of iron was neglected (33). Martin and Doyne (51) found soils having properties similar to lateritic soils had a low silica-sesquioxide ratio and a comparatively high silica-alumina ratio, the difference being due to the proportion of iron in the soils. Mohr and Van Baren (53) also indicated that iron should be considered for the identification of laterites. Robinson (61) felt that the SiO_2/Al_2O_3 or the SiO_2/R_2O_3 ratio gave significant information but strongly preferred the SiO_2/R_2O_3 ratio. The dividing limit of the SiO_2/R_2O_3 ratio for the grouping of some tropical soils was set at 2.0 by Bennett (6). The presence of quartz silica is not to be considered and is to be excluded from the silica calculations in determining either the SiO_2/R_2O_3 or the SiO_2/Al_2O_3 ratio according to Joffe (41).

Joffe (41) mentioned using the SiO_2/R_2O_3 of the C horizon as a basis of comparing the A and B horizons, since he felt only small amounts of amorphous silica penetrated beyond the B horizon. Barshad (5) also indicated that to measure the amount of weathering taking place the unweathered portion, or C horizon, should be used as a basis of comparison.

In addition to these ratios, Jenny (40) suggested still others. For example, for the detection of leaching of sodium and potassium of a soil horizon, he compared the $\frac{K_2O+Na_2O}{Al_2O_3}$ ratio of the parent material with

that of the leached layer. Since potassium and sodium are much more mobile than alumina, as this ratio became smaller, it indicated a greater degree of leaching.

Podzolization

The term "podzol" is defined in the USDA Yearbook (73) as a zonal group of soils having an organic mat on the surface overlying a thin organic mineral horizon under which are gray, leached horizons covering the dark brown, illuvial horizons. These soils developed in a cool, moist, temperate climate under conifers, mixed forests, or heath vegetation. Podzolization is further described as a process which causes the soils to become depleted of their bases, become strongly acid, and develops surface layers from which the clay is removed.

Joffe (42) studied the effects of climate, vegetation, and decomposition of organic matter and the resulting acids on the mechanism of podzolization. He explained how the acids cause breakdown of the carbonates and silicate minerals, thereby releasing bases, and the greater acidity produces an increased breakdown of clays, thus allowing iron and alumina to come into circulation and leaving the silica behind. He further explained that the bases released and the excess acids formed in the A horizon are carried down to the B horizon as are some of the dispersed clays causing the B horizon to become more compact. Much of the iron and alumina released from the A_2 horizon, due to the increased acidity, move down to the B horizon in the form of hydrated oxides accompanied by soluble humus compounds. These compounds are precipitated in the B horizon due to the higher pH. The sesquioxides

give rise to limonite and gibbsite upon dehydration.

Jenny (39) stated that the silica-alumina ratio is high in the A horizon and low in the B horizon of a podzol soil. He said this is due to the colloidal fraction having a relatively pronounced accumulation of Al_2O_3 in the B horizon and greatly enriched accumulation of SiO_2 in the A horizon compared to the C horizon colloidal fraction, and adds that he considered the colloidal fraction to be relatively stable and a product of the interacting soil factors.

Carter and Pendleton (19) indicated that podzolization occurred in the tropics as well as in the temperate regions, and they felt that the process of podzolization alone combined with erosion was sufficient to account for both podzols and latosols. They further stated that a laterite is a phenomenon of iron accumulation in the B horizon.

Grim (31) said that podzolic soils are developed under the conditions of a cool climate, sufficient rainfall to provide active leaching, and a vegetation, mostly forest, which provides abundant surface accumulation of organic matter and of such nature as to produce organic acids and other compounds of great potency of decomposition. The pH of the humus is commonly as low as 3.5 to 4.5 in the clay component, producing conditions which quickly dissolve the carbonates and remove the alkali and alkaline earths from the profile. He further stated that the base saturation ranges from approximately 20 to 80 percent, and more commonly between 40 to 60 percent. He added that due to the intense leaching conditions the inorganic colloidal complex becomes unstable in the surface horizons, and the iron and alumina are carried away and reprecipitated in vicinity of water table.

Bloomfield (9, 10, 11, 12, 13) in his studies on podzolization found that aqueous extracts of needles or leaves from each of a number of conifers and a broadleaf aspen were capable of producing a non-biological solution of ferric and aluminum oxides, reducing the ferric iron to the ferrous state. This he found to take place under neutral and aerobic conditions. The oxidation rate was low especially at the lower pH values. At pH 4.0 the oxidation products became precipitated, while at pH 7.0 a soluble ferric complex formed. He found bark extracts to also exhibit the properties of being able to reduce ferric and aluminum oxides, while aspen leaf extracts retained their activity to make soluble the iron and alumina compounds at high pH values. This he felt would explain the strong A_2 horizons in certain neutral or slightly acid soils. The fallen aspen leaves had a high content of soluble calcium and accounted for the high pH and percentage base saturation of the Gray Wooded Soils.

Deb (25) working on movement and precipitation of iron oxides in podzolic soils postulated a microbial mechanism for the precipitation of iron.

Joffe (41) stated that true podzols occur in the Upper Lakes region and the northern part of the New England States. These podzols were described as having a high degree of acid hydrolysis while in other podzolic soils the acid hydrolysis occurred to a lesser degree.

Thorp was quoted by Jenny (39) as stating that podzols characteristically have less clay in the surface than in the subsoil. Podzolization is a leaching process (50). Marbut (49) indicated that the primary criterion of podzolization is the relative accumulation of sesquioxides.

According to Joffe (41) podzolization becomes depressed as the tropics are approached. The degree of acid hydrolysis decreases, humus content decreases, mineralization becomes more rapid, iron and alumina accumulates, and the exchange capacity and degree of unsaturation decreases.

Laterization

The definition of the term "lateritic soils" are described in the USDA Yearbook (72) as a zonal group of soils which have very thin organic and organic-mineral layers overlying a reddish leached soil which rests on highly weathered material, relatively rich in iron oxide or hydrous alumina, or both, and low in silica; the color being usually deep red. Laterite soils are developed under the tropical forest in a climate which is hot and moist, with alternate wet and dry seasons with moderate to high rainfall. Laterization is described, in general, as the process which tends to produce laterites and lateritic soils. The term "laterite" was first used by Buchanan (57) in 1807 as a name for a highly ferruginous deposit he first observed in Malabar.

Bonnet (14) described laterites as products of usually basic rocks which are subjected to humid tropical weathering, this resulting in acidic material high in free sesquioxides, low in free silica and exchange capacity, very permeable to water and air, and usually exhibiting little or no differentiation into soil horizons, in some instances to a great depth.

Marbut (50) stated the silica portion of the silica minerals is lost more rapidly in lateritic soils than the iron and alumina portions;

quartz, being rather insoluble, is relatively unaffected by either process.

Mohr and Van Baren (53) defined the process of laterization as a concentrating of iron and aluminum hydroxides and a leaching out of silica, alkali, and alkaline earths. The aluminum hydroxide compound is partly combined with silica, this process being connected with the decomposition of residuary weathering products.

According to Joffe (41) laterites have a low SiO_2/R_2O_3 ratio, slightly acid to slightly alkaline hydrolysis, and a low base exchange capacity. He explained that the high temperature and moisture conditions of the tropics and subtropics produces a luxuriant vegetative growth as well as a rapid decomposition and mineralization of the organic matter. The circulation of the resulting released bases along with the low amount of organic acids causes the precipitation and accumulation in the A horizon of the iron, alumina, and manganese by keeping the pH rather high. Under these conditions the silicic acid which splits off remains in solution and becomes leached downward through the soil. Excess bases also tend to be leached out leaving the laterites slightly acid.

Grim (31) stated that the laterite soils develop under tropical conditions of high rainfall, which is often seasonal, and high temperature. The primary silicates are rapidly broken down, and the high rainfall causes quick removal of any alkalies and alkaline earths in solution. Oxidation of the iron tends to occur, particularly under seasonal rainfall, and its movement along with alumina is retarded. The organic material does not accumulate due to its rapid oxidation,

and downward-seeping waters carry little organic acids. As the result of the presence of alkalies and alkaline earths from the primary silicates, the downward moving waters are almost neutral or slightly alkaline. Under such conditions of slight alkalinity the silica tends to be dissolved and removed, resulting in a concentrating of the alumina and ferric oxide in the upper part of the weathering zone. High amounts of silica have been shown to be in the drainage waters of laterites (41, 50) and in Florida's surface and ground waters (8). A laterite that is completely developed contains no silica according to Marbut (50).

Joffe (42, 43) stated that laterites and lateritic soils accumulate titanium to a greater extent than soils of temperate climates. Karim (44) indicated that titanium accumulated in the A horizon of podzol profiles and believed it would accumulate in the B horizon of laterite profiles and, as such, could be an index for these soil forming processes. Sherman (64) stated that titanium oxide and iron oxide accumulate in tropical soils under the same conditions. Titanium becomes easily dehydrated at or near the surface to form concretions, coatings on surfaces of aggregates or soil particles, or forms a massive horizon; and under extreme reducing conditions, it is reduced and leached from the soil.

Prescott and Pendleton (57) and Kellogg (45, 46) disagreed with the use and meaning of the term laterite. Kellogg suggested the term latosol to replace it. Latosols were described (73) as being strongly leached and weathered, usually to great depths, forming in the Tropics and Subtropics in humid and fairly dry climates under forest and savanna

vegetation. Because of the large amount of iron oxide formed through intense leaching, red and yellow profile colors are common to latosolic soils. The plant nutrients are low. The Latosolic soils include the Laterites, Reddish-Brown Lateritic Soils, Yellowish-Brown Lateritic Soils, Red-Yellow Podzolic Soils, and several kinds of Latosols.

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Collection of Soil Profile Samples

A total of nine soil profiles of the finer-textured West Florida soils were collected for the purpose of studying the degree of podzolization and/or laterization taking place in these soils. The soil profiles selected belonging to the Marlboro, Faceville, Magnolia, and Greenville series and ranged in color from the yellow to the dark red soils. The soil profiles used were from Gadsden, Jackson and Washington Counties. Samples were taken from each horizon to a depth of 72 inches or more. Complete profile descriptions of each soil studied are included in Table III of Appendix. Only soils occurring on level or slightly sloping positions were considered. Field descriptions of the soil profiles included kind of soil, location, physiographic position, parent material, and also the thickness, color, texture, structure, consistence, and reaction of horizons within each profile.

The method of sample collection described in the Soil Survey Manual (68) was followed with the exception that samples collected below five feet were obtained with the aid of a post hole digger. Approximately one-gallon samples were taken, placed in cloth bags, labeled, and transported to the laboratory. After drying, approximately one pint-size samples were saved in the original condition, the remaining portions were crushed, passed through a 2mm. sieve, completely mixed by hand, and placed in gallon cartons, after which the samples were stored for further use.

Laboratory Studies

All laboratory determinations were performed in duplicate with the exception of the x-ray diffraction analyses.

[redacted]

Mechanical. Mechanical analyses of each soil horizon of all profiles were completed according to the method of Bouyoucos (15) as modified by Kilmer and Alexander (47). Mineral particles larger than 2mm. were labeled rocks, and were reported as percent rocks in the total soil.

Particle size distribution studies (5) of sand fractions were done to determine whether or not the soil profile had developed from the underlying parent material. The soil was soaked overnight, sodium oxalate and sodium silicate added, and dispersed with the aid of a Bouyoucos stirring machine. Distilled H_2O was added; then made up to a volume in a Bouyoucos cylinder. After the sands had settled, the liquid was siphoned off to within two inches of the sand. After this process was repeated, the remainder of the non-sand fraction was removed by wet-sieving through a 300 mesh sieve. The sand was fractionated through a nest of sieves of sizes 20, 40, 60, 140 and 200 mesh on a Ro-Tap testing sieve shaker according to the manufacturer's directions (71). Six minutes was found to be sufficient for the sieving operation. The sand fractions were then weighed and reported as percent of the total fractionated sands. Where a sudden large change occurred with depth for the individual size fractions, an occurrence of stratification was suspected for the profile (5). The organic matter was determined by the Wakely Black Method (76, 77). The exchange capacity of the soil was measured by the ammonium acetate method

described by Russel (63). The soil reaction was measured with the aid of a pH meter. The proportions of soil to water was 1:2.

[redacted]

The method of Jackson et al. (36) was used to separate the clay from the silt and sand components. The clay fractions were separated only at the two micron size. To eliminate microbiological growth in the clay suspensions while in storage, a few ml. of H_2O_2 were added and the bottles loosely stoppered.

X-ray Diffraction. An aliquot of each clay suspension was dried to determine the amount of clay per ml. of clay suspension. A portion of sufficient size to obtain 0.15 grams of clay was then taken and washed with 50 ml. of distilled H_2O; this process being repeated two times. The washed clay was then dispersed in 50 ml. of distilled water and adjusted to pH 3.5 by the dropwise addition of 1N HCl followed by centrifuging and discarding of the supernatant liquid, this process being repeated twice.

The magnesium-saturated clays were prepared by slowly adding 1N $Mg\text{-}C_2H_3O_2$ while stirring until flocculation began in each of the previously triple distilled-water-washed clay aliquots. This was followed by another washing with distilled water; then by adding 50 ml. of 1N $Mg\text{-}C_2H_3O_2$, dispersing by shaking for five minutes, centrifuging and decanting of the supernatant liquid, washing with distilled water, and the dispersing of each of the clays in 50 ml. of distilled water. A small portion of each clay suspension was placed on a petrographic slide and allowed to dry.

The slides containing the magnesium-saturated, glycerol-solvated clays were prepared by placing a few drops of glycerol in the water suspensions containing the magnesium-saturated clays; then stirring for five minutes, centrifuging five minutes at 2,000 rpm., discarding the supernatant liquid, resuspending in 50 ml. of distilled water, and a small portion placed on a clean petrographic slide to dry.

The prepared clay slides were placed in the specimen holder of a Norelco Geiger counter x-ray spectrometer equipped with a copper tube and a nickel filter. The machine was operated at 10 ma. and 40 KV. A 1/2 rpm. motor was used for all analyses with the result that five divisions on the recording paper represented 1° or 1/2 inch. The x-ray machine was calibrated using the 3.35 A. line of a quartz standard. X-ray diffraction patterns of the clays were recorded from 4° to 30°. The degrees were converted to A. units with the aid of charts and graphs prepared by W. Parrish and B. W. Irwin (56). The x-ray charts were interpreted with the aid of various books, cards, and charts (17, 31, 2, 67). To aid in distinguishing between chlorite and vermiculite, the slides of the magnesium-saturated clays were later heated to 500°C and analyzed on the x-ray diffraction machine (17).

[redacted]

The exchange capacities of the clays were measured with the aid of a method (30) employing the use of a centrifuge.

The sodium carbonate fusion method (58) was used to determine silica, alumina, iron, and titanium from which the various silica-sesquioxide

ratios were calculated (39). An aliquot from these determinations was used for potassium, magnesium, and calcium.

The amounts of calcium and potassium were measured on the Beckman B photometer (16), and the amounts of magnesium were measured on the Beckman DU (16) with a photo-multiplier, blanks being run in duplicate for each of the determinations. Loss on ignition for the clay fraction was determined by a method described by Prinse (58).

RESULTS AND DISCUSSION

Mechanical analyses were made to characterize the various soil horizons and to aid in selecting the A, B, and C horizons (68). The results of these analyses are reported in the Appendix. The percent clay in the A horizons (see Table 1) ranged from 4.8 (in the Magnolia I) to 25.7 (in the Greenville III), while the B horizon clay fractions ranged from 26.5 (in the Magnolia I) to 32.7 (in the Magnolia II), and in the C horizon from 21.5 (in the Greenville III) to 35.3 (in the Magnolia I).

The percent silt in the A horizons varied from 7.5 (in the Greenville III) to 12.7 (in the Greenville IV); in the B horizons from 6.5 (in the Magnolia II) to 9.7 (in the Marlboro I); and in the C horizons from 4.1 (in the Greenville III) to 10.2 (in the Greenville I).

To determine whether or not stratification was present and, if so, where it occurred, the whole non-clay fraction of each horizon was sieved and the proportion of each separate studied in relation to the adjacent layers (see Figure 1 and Table I of Appendix). If an appreciable change in percentage occurred in any one or more of the sand fractions it was considered that stratification had taken place, since it is unlikely that two different strata would have nearly the same ratios of sand separates (5). In the 0.42 mm. to 0.25 mm. sand fraction of the Marlboro I profile the percent ranged from 9.3 to 9.6 from the surface to the depth of 46 inches; in the next horizon, 54 to 60 inches, the percent increased to 11.5 indicating a change to a different strata. This change is also reflected in the 0.105 mm. to 0.074 mm. sand fraction. In this fraction

TABLE 1

SOIL ANALYSES

MARLBORO I

Depth Ins.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles < 2 mm. diameter Sand	Silt	Clay
0-2	3.125	4.84	5.27	0.672	85.7	10.2	4.1
2-8	1.195	2.39	5.25	0.633	86.3	8.9	4.8
8-13	0.288	2.35	5.15	0.378	74.8	6.4	18.8
13-20	0.479	3.23	5.20	0.624	67.0	7.6	25.4
20-30	0.319	3.17	5.10	0.349	62.7	9.7	27.6
30-36	0.153	2.91	5.07	0.241	63.7	10.2	26.1
36-46	0.155	2.48	5.08	0.122	63.9	9.4	26.7
54-60	0.158	2.88	5.08	0.011	61.4	10.9	27.7
72-78	0.068	5.99	5.05	0.007	59.8	6.3	33.9

[redacted]

Depth Ins.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles < 2 mm. diameter Sand	Silt	Clay
0-7	1.794	3.38	5.35	0.395	85.3	11.3	3.4
7-12	0.974	2.00	5.65	0.356	80.9	9.0	10.1
12-18	0.461	3.87	5.55	1.678	65.5	8.5	26.0
18-30	0.369	3.41	5.55	4.558	63.0	7.9	29.1
30-36	0.251	3.01	5.45	5.475	64.0	7.3	28.7
36-42	0.228	2.82	5.59	8.208	64.0	6.9	29.1
42-50	0.102	3.10	5.40	11.756	64.6	6.7	28.7
50-60	0.157	2.95	5.45	2.623	66.3	5.2	28.5
60-68	0.179	2.74	5.45	10.925	66.9	4.7	28.4
72-82	0.130	2.63	5.50	5.134	66.2	7.3	26.5

TABLE 1 (continued)

FACEVILLE II

Depth In.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles < 2 mm. diameter Sand	Silt	Clay
0-1	1.796	1.95	5.53	0.505	91.2	5.6	3.2
1-7	0.849	1.20	5.40	0.650	88.6	7.4	4.0
7-11	0.801	1.90	5.30	1.068	81.4	10.2	8.4
11-20	0.687	3.26	5.07	0.513	62.8	7.1	30.1
20-30	0.428	3.31	4.82	0.485	61.6	6.7	31.7
30-38	0.455	3.36	5.05	0.325	60.4	7.3	32.3
38-44	0.384	3.40	4.77	0.233	60.2	8.9	30.9
44-52	0.452	3.61	4.87	0.314	63.0	6.7	30.3
52-56	0.400	4.20	4.83	0.243	61.0	8.2	30.8
56-64	0.102	3.66	5.03	0.363	58.2	9.1	32.7
77-81	0.116	6.92	4.95	0.039	41.8	11.1	47.1

MAGNOLIA I

Depth In.	% O.M.	[redacted] Cap.	pH	% Rocks	% Mineral Particles < 2 mm. diameter Sand	Silt	Clay
0-6	3.126	4.29	5.47	2.219	85.7	11.7	2.6
6-11	1.332	2.14	5.55	0.998	84.8	9.6	5.6
11-14	0.639	2.19	5.45	1.436	81.9	8.4	9.7
14-25	0.560	3.45	5.42	1.626	69.5	5.9	24.6
25-39	0.507	3.35	5.30	0.860	64.6	8.9	26.5
39-48	0.361	3.06	4.85	0.309	62.1	6.1	31.8
48-55	0.321	3.41	4.98	0.039	57.2	7.5	35.3
55-64	0.283	3.31	4.95	0.036	55.6	7.3	37.1
64-72	0.191	5.72	5.42	0.016	55.8	6.9	37.3

TABLE 1 (continued)

MAGNOLIA II

Depth In.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles < 2 mm. diameter Sand	Silt	Clay
0-3	2.608	4.18	5.89	0.517	86.5	10.9	2.6
3-9	1.032	2.06	5.79	0.621	86.4	9.0	4.6
9-20	0.727	4.92	5.25	0.671	62.6	6.9	30.5
20-26	0.379	4.35	5.45	1.879	60.8	6.5	32.7
26-38	0.210	3.55	5.38	1.251	65.9	5.4	28.7
38-50	0.173	3.06	5.60	0.667	67.7	6.5	25.8
50-60	0.075	3.49	5.59	0.231	69.8	5.0	25.2
60-70	0.105	3.64	5.23	0.308	73.4	3.4	23.2
70-80	0.101	4.19	5.17	1.193	73.8	3.0	23.2

GREENVILLE I

Depth In.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles < 2 mm. diameter Sand	Silt	Clay
0-5	2.700	5.80	6.52	0.861	81.8	13.4	4.8
5-10	0.800	2.45	6.04	1.336	79.8	9.3	10.9
10-14	0.566	3.82	5.92	1.093	67.3	9.6	23.1
14-20	0.548	4.02	5.38	1.160	61.5	8.4	30.1
20-30	0.390	3.48	5.28	1.287	61.5	7.7	30.8
30-36	0.263	3.42	5.28	1.438	62.0	6.9	31.1
36-44	0.161	3.02	5.22	1.806	61.9	6.5	31.6
44-50	0.140	3.08	5.15	0.513	57.6	10.8	31.6
50-60	0.130	3.08	5.22	1.795	60.9	7.5	31.6
72-78	0.089	3.07	5.22	0.134	58.3	10.2	31.5

TABLE 1 (continued)

GREENVILLE II

Depth In.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles <2 mm. diameter Sand	Silt	Clay
0-6	1.312	2.45	6.55	0.399	83.4	11.6	5.0
6-9	0.580	2.00	6.61	0.433	84.4	9.7	5.9
9-18	0.402	3.07	6.06	2.036	68.6	8.7	22.7
18-28	0.239	3.69	6.00	1.983	61.0	9.5	29.5
28-38	0.143	3.42	5.45	1.127	62.0	9.5	28.5
38-48	0.110	2.77	5.38	1.514	63.4	6.5	30.1
48-60	0.116	2.97	5.35	3.465	62.1	7.1	30.8
60-72	0.116	2.74	5.02	2.685	63.1	6.2	30.7

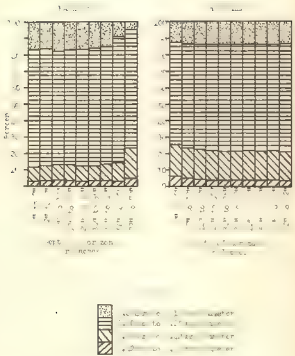
GREENVILLE III

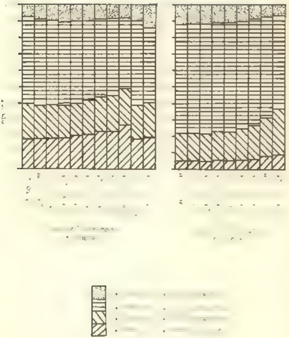
Depth In.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles <2 mm. diameter Sand	Silt	Clay
0-6	2.026	3.61	5.79	0.401	78.1	11.1	10.8
6-12	0.585	3.44	5.62	0.375	66.8	7.5	25.7
12-22	0.376	3.06	5.38	0.472	64.2	5.6	30.2
22-30	0.212	3.32	5.25	0.448	63.1	8.5	28.4
30-38	0.185	2.72	5.35	0.414	67.2	3.2	29.6
38-48	0.171	2.42	5.55	0.479	68.7	4.7	26.6
48-60	0.157	2.37	5.62	0.549	69.0	5.4	25.6
60-72	0.359	2.01	5.60	0.455	74.4	4.1	21.5
72-78	0.116	1.86	5.47	0.522	73.8	4.5	21.7

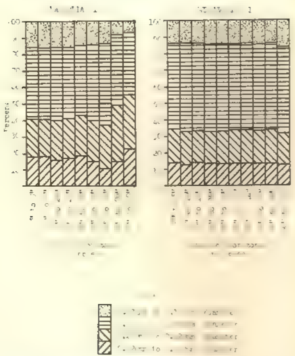
TABLE 1 (continued)

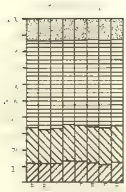
GREENVILLE IV

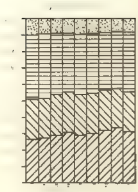
Depth In.	% O.M.	Exch. Cap.	pH	% Rocks	% Mineral Particles < 2 mm. diameter Sand	Silt	Clay
0-3	3.513	6.31	6.11	0.662	80.5	14.7	4.8
3-7	1.404	5.65	6.23	0.846	78.8	12.7	8.5
7-14	0.754	3.98	5.52	0.566	68.1	12.5	19.4
14-23	0.396	4.49	5.15	0.975	64.1	9.5	26.4
23-30	0.349	4.36	5.12	1.200	61.8	9.3	28.9
30-40	0.224	4.34	4.88	1.248	62.1	7.5	30.4
40-48	0.197	4.19	5.12	1.815	62.1	6.4	31.5
48-56	0.157	3.95	5.06	3.399	62.2	6.9	30.9
56-64	0.157	3.65	4.90	1.836	64.2	6.9	28.9
64-72	0.156	3.51	4.88	1.119	68.1	5.3	26.6
80-86	0.142	3.48	5.06	1.366	68.8	4.6	26.6











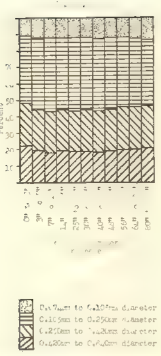
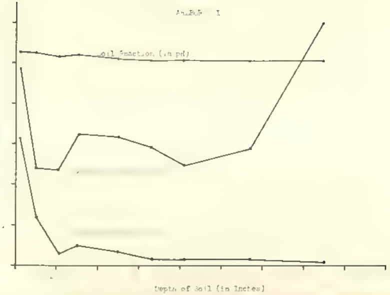


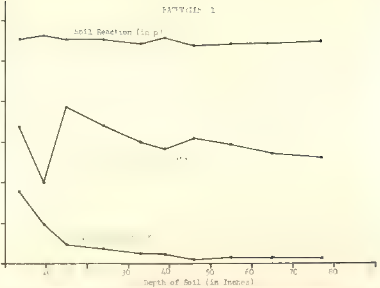
Figure 1. Percent of Various Sized Separates in Sand Fractions of Soil Horizons

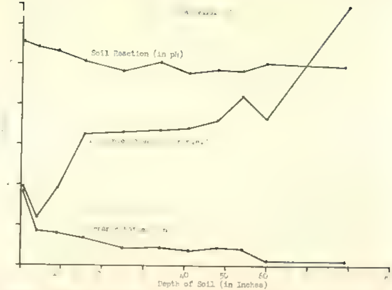
the percent changes sharply from 15.0 at the 36 to 46 inch depth to 9.2 at the 54 to 60 inch depth. The other sand fractions also showed this change but to a lesser degree. This study is important since the amount of weathering of the A and B horizons is based on the unweathered state of the materials from which they were developed (39). Since there was no change in soil material found to the depth of 54 inches in the Marlboro I profile, the C horizon was therefore chosen in this and all subsequent profiles to be the deepest horizon in which no stratification was evident. This proved to be the 44 to 52" horizon in the Faceville II; the 48 to 55" horizon in the Magnolia I; and the 38 to 50" depth in the Magnolia II. The C horizons chosen for the profiles found free of stratification were 60 to 68" depth for the Faceville I, 72 to 78" for the Greenville I, 60 to 72" for the Greenville II, 60 to 72" for the Greenville III, and 64 to 72" for the Greenville IV.

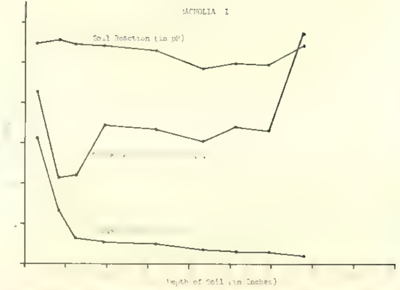
Organic matter (see Figure 2) was the highest in the surface layers and decreased with depth. The surface soil ranged from 1.3 percent organic matter (in the Greenville II) to 3.5 percent (in the Greenville IV). The organic matter of the B horizons varied from a low of 0.21 percent (in the Greenville III) to a high of 0.51 percent (in the Magnolia I). In the C horizons organic matter varied from 0.45 percent (in the Faceville II) to 0.89 percent (in the Greenville I). Complete results are listed in the Appendix.

Exchange capacities of the surface horizons were measured for the whole soil (see Figure 2) and varied from 1.95 m.e./100 grams (in the


Soil Reaction (in pH)
Depth of Soil (in Inches)


Soil Reaction (in p
30
40
50
60
70
80
Depth of Soil (in Inches)


Soil Reaction (in pH)
40
50
60
Depth of Soil (in Inches)


MAGNOLIA I
Soil Reaction (in pH)
Depth of Soil (in Inches)

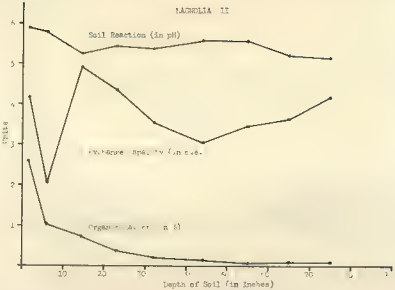
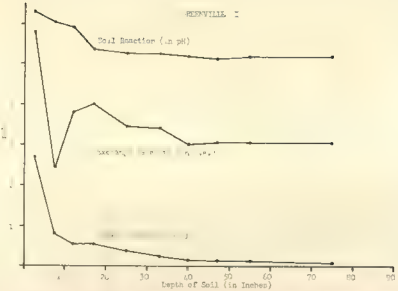
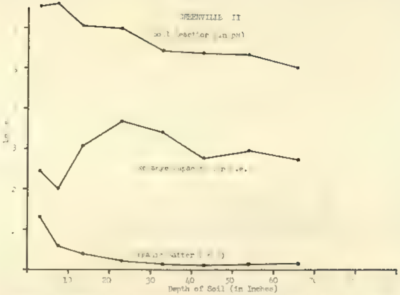


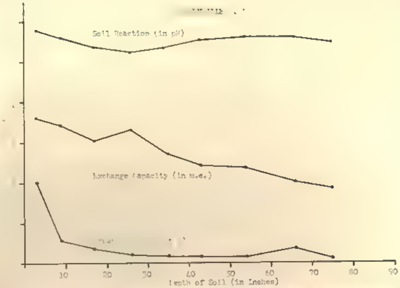
Figure 2. Organic Matter, Exchange Capacity, and Reaction of Soil in Relation to Depth

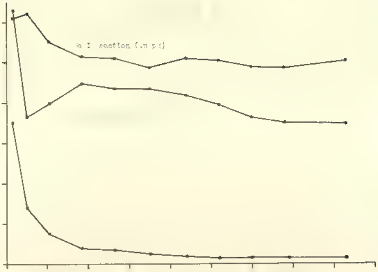


Soil Reaction (in pH)
1
20
30
40
50
60
70
80
90
Depth of Soil (in Inches)



[illegible] reaction o[illegible] soil in relation to depth


Soil Reaction (in pH)
Exchange Capacity (in m.e.)
10
20
30
40
50
60
70
80
90
Depth of Soil (in Inches)



Faceville II) to 6.31 m.e. (in the Greenville IV). The A horizons chosen for further analysis ranged from 1.90 m.e. (in the Faceville II) to 3.65 m.e. (in the Greenville IV), while the B horizon varied from 3.17 m.e. (in the Marlboro I) to 4.36 m.e. (in the Greenville IV), and the C horizon varied from 2.01 m.e. (in the Greenville III) to 3.61 m.e. (in the Faceville II). The exchange capacity values for the whole soil increased with increasing amounts of organic matter and clay contents. The values were higher at and near the surface due to the abundance of organic matter although low in clay. The horizons just below the surface layers, being low in both organic matter and clay, were found to decrease in their exchange capacities, while the B horizons, having an abundance of clay but little organic matter, were found to have intermediate exchange capacity values.

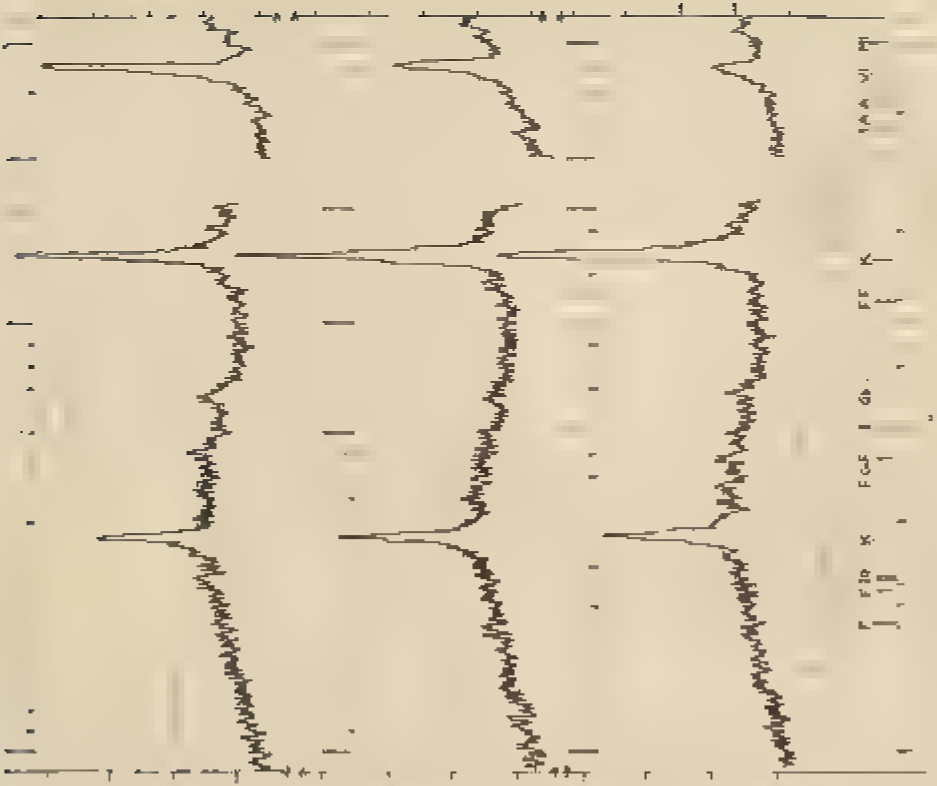
The soil reaction (see Figure 2) of the soil horizons varied from slightly acid to strongly acid. Also the pH values were generally lower in the Marlboro and Faceville profiles, somewhat higher in the Magnolia, and highest in the Greenville profiles. The Greenville II was the only profile studied which had been cultivated and limed, and these management practices probably account for the higher pH values in the A and B horizons of this profile. In general, the pH values of the profiles increased as the color of the soils varied from yellow to dark red. This seems to be consistent with the trend of lower pH values as soils become more podzolic and higher pH values as soils become more lateritic (41, 42).

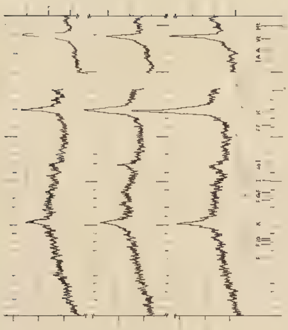
There has been considerable amount of work done studying clays and their pedogenesis (35). Minerals weather as the result of temperature-change, moisture-transfer, and chemical action. The rate of weathering

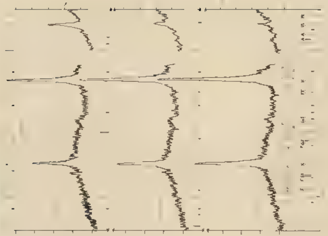
is also affected by the particle size and specific nature of minerals. As the intensity of the weathering factors increase, weathering proceeds through a weathering sequence of clay minerals as follows: gypsum, calcite, hornblende, biotite, albite, quartz, illite, mica-intermediate, montmorillonite, kaolinite, gibbsite, hematite, and anatase. The weathering trend is usually towards the right although it is reversible. Usually one or two minerals are dominant with three to five present in the colloid of any one horizon. The composition of the soil colloid minerals varies according to geographic climatic variations and proximity to surface of the soil. In normal soils illite, montmorillonite, and kaolinite are prominent; and in laterites, gibbsite, hematite, and anatase predominate.

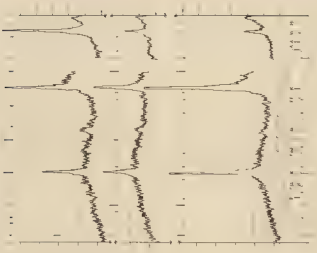
In noncalcic podzolic soils, illite tends to decrease while vermiculite forms (37). In latosolic soils, with increased leaching desilication causes vermiculite to decrease and kaolinite to increase; and in latosols kaolinite decreases and gibbsite forms. Under dry conditions vermiculite and kaolinite form, while under moist conditions montmorillonite and halloysite form.

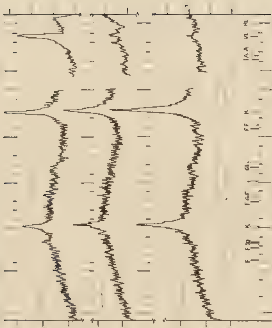
The clay minerals were identified and an estimate of the amounts present was made to determine whether they were near or within the range of laterite clay minerals and to determine their relative position in the weathering scale sequence. The dominant clay minerals in the Marlboro I profile (Figure 3 and Table 2) were kaolinite and vermiculite; other clays present were gibbsite, montmorillonite and quartz. The quantity of kaolinite was fairly constant throughout the profile; the amount of

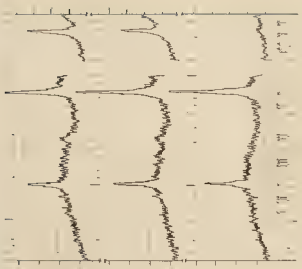


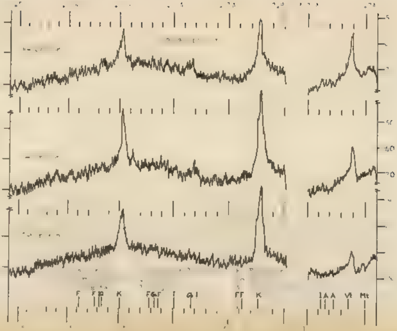


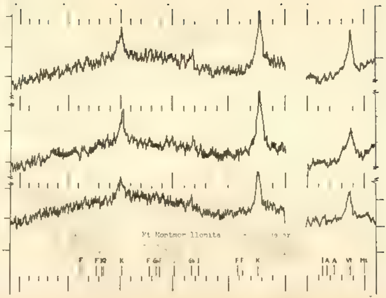









K
K
Mt
40
20


Mt Montmorillonite

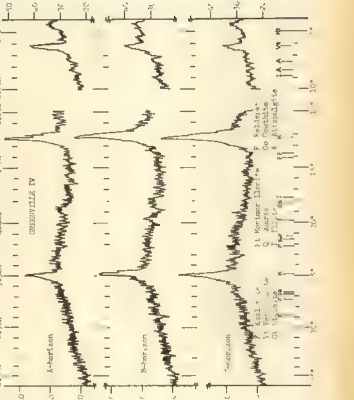


Figure 3. X-ray Patterns of the Clay Fractions

TABLE 2

CLAYS* IDENTIFIED IN THE SOIL HORIZONS

MARLBORO I		
2"-8"	A	KAOLINITE, VERMICULITE, gibbsite, montmorillonite, [redacted]
20"-30"	B	KAOLINITE, VERMICULITE, gibbsite, montmorillonite, quartz
36"-46"	C	KAOLINITE, vermiculite, gibbsite
FACEVILLE I		
7"-12"	A	KAOLINITE, VERMICULITE, GIBBSITE
18"-30"	B	KAOLINITE, VERMICULITE, GIBBSITE
60"-68"	C	KAOLINITE, VERMICULITE, GIBBSITE, illite, quartz
FACEVILLE II		
7"-11"	A	KAOLINITE, VERMICULITE, gibbsite, montmorillonite, quartz
20"-30"	B	KAOLINITE, VERMICULITE, gibbsite, montmorillonite,
44"-52"	C	KAOLINITE, VERMICULITE, gibbsite, montmorillonite
MAGNOLIA I		
6"-11"	A	KAOLINITE, VERMICULITE, GIBBSITE, montmorillonite, quartz, feldspar
25"-39"	B	KAOLINITE, VERMICULITE, gibbsite
45"-55"	C	KAOLINITE, VERMICULITE, gibbsite, montmorillonite
MAGNOLIA II		
3"-9"	A	KAOLINITE, VERMICULITE, gibbsite
20"-26"	B	KAOLINITE, VERMICULITE, gibbsite, goethite
38"-50"	C	KAOLINITE, vermiculite, gibbsite

TABLE 2 (continued)

[redacted]		
5"–10"	A	KAOLINITE, VERMICULITE, GIBBSITE, montmorillonite, quartz
20"–30"	B	KAOLINITE, VERMICULITE, gibbsite, montmorillonite, quartz
72"–76"	C	KAOLINITE, vermiculite
<u>GREENVILLE II</u>		
6"–9"	A	KAOLINITE, VERMICULITE, GIBBSITE
18"–28"	B	KAOLINITE, VERMICULITE, gibbsite, montmorillonite, feldspar
60"–72"	C	KAOLINITE, VERMICULITE
<u>GREENVILLE III</u>		
6"–12"	A	KAOLINITE, VERMICULITE, GIBBSITE, quartz, feldspar
22"–30"	B	KAOLINITE, VERMICULITE, GIBBSITE, montmorillonite
60"–72"	C	KAOLINITE, VERMICULITE, GIBBSITE
[redacted]		
3"–7"	A	KAOLINITE, VERMICULITE, GIBBSITE, montmorillonite, attapulgite
23"–30"	B	KAOLINITE, VERMICULITE, gibbsite, montmorillonite
64"–72"	C	KAOLINITE, VERMICULITE, montmorillonite

*Clays present in relatively large amounts are typed in capitals; those in lesser amounts are indicated by small letters.

vermiculite increased from the C horizon to the A horizon, this being typical of a podzol environment (37). Gibbsite was present in only small quantities throughout the profile; quartz increased somewhat towards the surface.

In the Faceville I profile kaolinite content decreased from the C to the A horizon while vermiculite remained fairly constant in all the horizons; gibbsite was slightly less in the A when compared to B and C horizons. Illite was detected only in the C horizon. The pattern of the clay minerals of this profile was somewhat indicative of a podzol soil since illite tended to disappear in the surface, and vermiculite persisted. Kaolinite and vermiculite were also the dominant minerals in the Faceville II profile. The content of kaolinite decreased towards the surface, while vermiculite increased towards the surface. The pattern of these minerals was also typical of a podzol profile.

Vermiculite increased considerably in the A horizon in comparison to the B and C horizons of the Magnolia I profile. Kaolinite content was greatest in the C and least in the B horizon. Gibbsite content increased from the C to the A horizon. The pattern of the clay minerals in this profile indicated a transitional soil having features of both the podzol and the latosol, since vermiculite and gibbsite increased with nearness of the surface. Kaolinite was the dominant clay in the A, B, and C horizons of the Magnolia II, although it was present in lesser amounts near to the surface. Vermiculite was a dominant mineral in the A and to a much lesser extent in the B horizon. Gibbsite was detectable in all horizons. The mineral pattern resembled a podzol profile since vermiculite increased towards the surface.

In the Greenville I profile vermiculite was present in a very small amount in the C horizon while there was considerable present in the B, and the greatest amount in the A horizon. Kaolinite was present in all horizons in large amounts with a trend of slightly decreasing amounts with nearness to the surface. Gibbsite increased from the C to the A horizon, and montmorillonite was detectable only in the A and B horizons. The pattern of mineral distribution in this profile exhibited features of both latosols and podzols since amounts of gibbsite and vermiculite both increased towards the surface, and amounts of kaolinite slightly decreased with nearness towards the surface. Kaolinite was present in large amounts in all horizons of the Greenville II profile with slightly more being present in the B horizon. Vermiculite and gibbsite increased towards the surface. The clay minerals of the profile also had a podzolic and latosolic pattern since gibbsite formed in the upper horizon, kaolinite remained almost constant, and vermiculite increased to some extent towards the surface. The Greenville III profile also resembled a transition type profile since the kaolinite clay mineral increased towards the surface and gibbsite increased steadily towards the surface. Vermiculite showed a maximum in the A horizon while the least amount was present in the C horizon. The pattern of the clay minerals of the Greenville IV profile was very similar to other Greenville profiles.

The exchange capacity of the clay fraction of the A horizons ranged from 15.7 m.e./100 gms. (for the Greenville III) to 25.1 m.e. (for the Magnolia II). Similar values for the B horizons ranged from 14.1 m.e. (for the Greenville III) to 20.6 m.e. (for the Marlboro I). In the C

horizons the lowest exchange capacity value was 14.3 m.e. (for the Faceville II) and the highest was 21.1 m.e. (for the Faceville I profile). Complete data is given in the Appendix. The exchange capacities of the profiles were too large to be accounted for by kaolinite clay (3 to 13 m.e./100 gms.) or by other clays of low exchange capacity; therefore the presence of clays with higher exchange capacities such as vermiculite, illite, or montmorillonite (1, 67) was suggested. The presence of vermiculite was identified by the x-ray diagram patterns (14 Angstroms) and verified by a shift of the basal spacing after heating the slides to 500°C (67). In general, the exchange capacity of the clay fraction increased as the height of the vermiculite and montmorillonite x-ray peaks increased.

The oxides of iron, alumina, and silica of the clays in the A, B, and C horizons of each of the profiles were determined; results are reported in the Appendix. From these values, silica-sesquioxide and silica-alumina values (Table 3) were also determined. To detect the type of weathering process taking place in the profiles, the silica-sesquioxide ratios of the C horizons were taken as unity and graphed with the respective silica-sesquioxide ratios of the A and B horizons. The same procedure was followed for the silica-alumina ratios (Figure 4). In the A horizon of Marlboro I profile the silica-sesquioxide value was 1.05 and is thus plotted above the unity line, the value for the B horizon was 0.97 and thus falls below the unity line, and the value for the C horizon is, of course, unity. This is a typical podzolization graph. The higher the silica-sesquioxide value of the A horizon and the lower

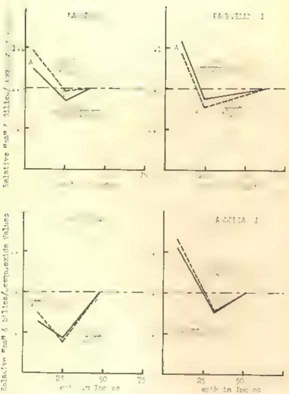


Figure 4. [illegible] Silica/Alumina and Silica/Sesquioxide Ratios of the Clay Fraction of the A, B, and C Soil Horizons

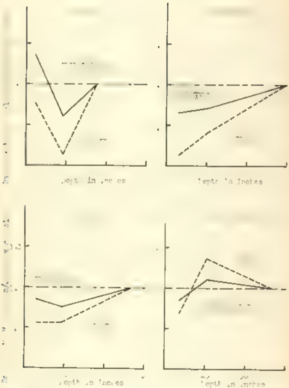
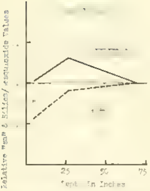


Figure 4. Relative Silica/Alumina and Silica/Sesquioxide Ratios of the Clay Fraction of the A, B, and C Soil Horizons



[illegible]
of the Clay Fraction of the A, , and C Soil Horizons

TABLE 9

RATIO STUDIES OF CLAYS IN SOIL HORIZONS

	Horizon	Depth in Inches	Silica Alumina Ratio	Silica Sesquioxide Ratio
MARLBORO I	A	2-8	2.35	1.731
	B	20-30	2.14	1.598
	C	36-46	2.15	1.645
PACEVILLE I	A	7-12	2.38	1.707
	B	18-30	2.09	1.490
	C	60-68	2.19	1.527
PACEVILLE II	A	7-11	2.54	1.628
	B	20-30	2.35	1.562
	C	44-52	2.68	1.763
MAGNOLIA I	A	6-11	2.33	1.622
	B	25-39	1.97	1.386
	C	46-55	2.06	1.462
MAGNOLIA II	A	3-9	2.90	1.794
	B	20-26	2.51	1.537
	C	38-50	3.04	1.673
GREENVILLE I	A	5-10	2.26	1.590
	B	20-30	2.41	1.609
	C	72-78	2.74	1.705
GREENVILLE II	A	6-9	2.20	1.680
	B	18-28	2.80	1.590
	C	60-72	2.41	1.674
GREENVILLE III	A	6-12	1.79	1.309
	B	22-30	2.05	1.381
	C	60-72	1.91	1.352
GREENVILLE IV	A	3-7	2.59	1.621
	B	23-30	2.78	1.705
	C	64-72	2.84	1.610

this value of the B horizon, the greater the degree of podzolization (39). The Marlboro I profile indicates a slight degree of podzolization. The graph of the Faceville I profile shows slightly more podzolization, while the graph of the Faceville II profile indicates only a slight degree of podzolization. Both Magnolia profiles (I and II) also have typical podzol curves. In the Greenville I profile, the value of the A horizon is below unity (0.93) and the value of the B horizon is also below unity (0.94) but to a slightly lesser degree giving a straight line curve from below unity to unity, a typical laterite curve (39). The amount of laterization, however, is slight in the Greenville I profile. The shape of the graph of the Greenville II profile indicates very slight podzolization. In the Greenville III profile a lateritic type of curve is shown. The silica-sesquioxide value for the A horizon is below unity (0.97) indicating an accumulation or slower loss of iron and alumina than of silica; the value for the B horizon is above unity (1.02) showing an accumulation or slower loss of silica than of iron and alumina. The graph of the Greenville IV profile is somewhat similar in shape to that of the Greenville III profile and has a very lateritic type of curve. All Greenville profiles indicates an accumulation of iron and alumina in the A horizons as compared to their respective C horizons.

The results of this study show no strong trend in either direction, podzolization or laterization. This could be expected since the soils under study are believed to be in the transition zone of podzolization and laterization (50). The values of the silica-alumina ratio seems to parallel those of the silica-sesquioxide ratios (Figure 4).

The vegetation forms of the sampling sites tends toward hardwoods on the redder soils while pines were predominant on the more yellow soils under study (24). This data is listed below:

Soil Profile	Vegetation Form
Marlboro I	Pines
Faceville I	Pines
Faceville II	Pines and Hardwoods
Magnolia I	Hardwoods
Magnolia II	Pines
Greenville I	Hardwoods
Greenville II	Hardwoods
Greenville III	Hardwoods
Greenville IV	Hardwoods

SUMMARY

A study of development of certain finer-textured, well-drained soils of West Florida was made to determine the dominant soil-forming process operating in the area and to identify the clay minerals in the [illegible]

Nine profiles of the four more prevalent soil series in this area - Marlboro, Faceville, Magnolia, and Greenville - were selected from level to nearly level topography. Each observable horizon to a depth of 72 or more inches in the profiles was sampled.

The particle size distribution of the sand fraction of each horizon was measured to determine whether or not the soil profile had developed from the under-lying parent material. The sand was fractionated through a nest of sieves of sizes 20, 40, 60, 140, and 200 mesh. The fractions were weighed and reported as percent of the total fractionated sands. Where a relatively large change in percent of the individual size fractions occurred between adjacent horizons, stratification was indicated at that point in the profile.

Organic matter, exchange capacity, and soil reaction was measured on samples of the whole soil of each horizon.

On the clay portion x-ray diffraction studies were performed to identify the clay minerals, and peak height comparisons were made of the A, B, and C horizons of each profile to detect the relative build-up or loss of the minerals in the surface horizons. Chemical analyses of the clay fraction included the determinations of SiO_2, Fe_2O_3, and

Al_2O_3. From these analyses, the silica-sesquioxide ratios and the "ea" values were calculated to aid in determining the dominant soil forming process taking place in the soils under study. Other chemical measurements on the clay fraction included exchange capacity and TiO_2.

The results indicated the following:

1. Stratification was found to occur below depths of 54 inches in the Marlboro profile, 52 inches in the Faceville II, 55 inches in the Magnolia I, and 50 inches in the Magnolia II. The Faceville I and all Greenville profiles were found to be free of stratification within the depths studied.

2. The interpretations of the "ea" and the silica-sesquioxide ratios were of approximately equal value in determining the degree of podzolization or laterization.

3. The podzolization process was slightly dominant in the Marlboro I, Faceville I, and both Magnolia soils.

4. In all Greenville soils, laterization was slightly dominant.

5. The pH values of horizons of preferential leaching of silica were higher than of the horizons of preferential leaching of iron and alumina.

6. Kaolinite and vermiculite were the dominate clay minerals in all profiles studied; gibbsite was also present in relatively large quantities in the Faceville I, Magnolia I, and all Greenville profiles.

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APPENDIX

APPENDIX TABLE 1

PERCENT OF VARIOUS SIZED SEPARATES IN SAND FRACTIONS OF SOIL HORIZONS

[redacted]

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-2	2.8	9.3	71.2	16.7
2-8	3.1	9.4	71.1	16.4
8-13	3.4	9.4	69.6	17.6
13-20	3.4	9.3	69.9	17.4
20-30	3.2	9.4	70.5	17.0
30-36	3.4	9.5	71.2	16.0
36-46	3.4	9.6	72.0	15.0
54-60	2.9	11.5	76.5	9.2
70-78	5.0	19.2	71.0	4.8

[redacted]

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-7	6.2	19.4	62.0	12.5
7-12	5.1	18.4	63.7	13.1
12-18	4.5	18.2	64.0	13.4
18-30	4.2	17.9	64.3	13.6
30-36	4.2	17.4	64.9	13.6
36-42	4.2	17.8	64.6	13.4
42-50	4.2	18.2	64.6	13.1
50-60	4.1	17.5	65.1	13.3
60-68	4.2	17.7	64.8	13.3
78-88	3.6	17.6	65.6	13.2

APPENDIX TABLE 1 (continued)

PAGEVILLE II

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-1	18.2	21.6	52.7	7.4
1-7	18.1	20.4	52.4	9.2
7-11	18.5	20.5	50.9	9.9
11-20	18.9	19.7	51.0	10.3
20-30	20.2	19.9	49.7	10.2
30-38	21.0	20.9	48.6	9.5
38-44	23.3	21.3	46.7	8.7
44-52	23.3	21.8	46.2	8.6
52-56	26.8	22.3	42.7	8.0
56-64	18.1	20.4	51.6	9.8
77-81	19.5	20.7	48.9	11.5

MAGNOLIA I

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-6	5.3	16.8	66.1	11.8
6-11	5.1	17.0	66.2	11.7
11-14	4.9	16.7	66.5	11.9
14-25	5.6	17.5	65.3	11.6
25-39	5.5	17.3	65.7	11.5
39-48	5.7	18.9	65.4	10.1
48-55	5.9	20.6	65.0	8.6
55-64	7.7	23.8	61.0	7.5
64-72	9.3	27.1	56.6	7.0

APPENDIX TABLE 1 (continued)

MAGNOLIA II

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-3	17.7	23.1	43.7	15.5
3-9	18.0	22.3	43.7	16.0
9-20	15.7	24.2	44.1	16.1
20-26	17.2	23.6	43.2	16.0
26-38	18.1	24.8	42.6	14.5
38-50	15.0	24.8	45.8	14.4
50-60	10.9	26.2	49.2	13.7
60-70	15.0	34.2	42.6	8.2
70-80	22.5	32.9	37.5	7.1

GREENVILLE I

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-5	14.3	20.6	52.0	13.2
5-10	12.6	20.9	51.7	13.7
10-14	13.9	19.8	52.5	13.9
14-20	13.2	19.6	52.3	14.0
20-30	13.2	19.6	53.3	13.9
30-36	13.6	19.8	52.7	13.8
36-44	13.6	20.3	52.7	13.4
44-50	13.0	20.5	52.0	14.5
50-60	13.6	20.4	52.5	13.5
72-78	12.7	19.2	52.3	15.9

APPENDIX TABLE 1 (continued)

GREENVILLE II

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-6	12.2	21.4	53.3	13.0
6-9	11.5	20.8	54.2	13.5
9-18	11.8	21.3	53.6	13.3
18-28	13.4	21.9	52.4	12.7
28-38	12.8	22.3	53.6	12.7
38-48	12.3	22.1	53.0	12.6
48-60	11.3	22.2	53.6	12.9
60-72	12.9	22.0	52.6	12.5

GREENVILLE III

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-6	26.6	24.4	39.5	9.6
6-12	27.5	24.7	38.7	9.1
12-22	29.5	24.8	37.0	8.6
22-30	30.8	24.6	36.4	8.3
30-38	29.5	24.8	36.9	8.9
38-48	30.2	24.9	36.3	8.5
48-60	32.3	24.6	35.0	8.2
60-72	33.7	24.1	34.5	7.7
72-78	31.5	24.2	36.2	8.0

APPENDIX TABLE 1 (continued)

GREENVILLE IV

Horizon Depth In.	0.84mm. to 0.42mm. %	0.42mm. to 0.25mm. %	0.25mm. to 0.105mm. %	0.105mm. to 0.074mm. %
0-3	22.5	25.9	41.3	10.3
3-7	19.8	24.8	43.9	11.5
7-14	18.2	25.0	44.8	12.0
14-23	19.5	24.7	43.9	12.0
23-30	18.9	24.8	44.3	12.0
30-40	19.1	25.1	44.8	11.9
40-48	18.5	24.8	44.5	12.3
48-56	19.3	25.4	43.6	11.7
56-64	19.9	25.9	42.6	11.5
64-72	20.0	25.9	42.1	11.9
80-86	20.7	25.7	40.8	12.9

APPENDIX TABLE 2

CLAY ANALYSES OF A, B, AND C HORIZONS

MARLBORO I

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	% SiO_2	% Fe_2O_3	% Al_2O_3	% TiO_2	% Ca	% Mg	% K
2-8	4.8	19.3	13.9	42.0	16.9	30.4	.01040	.00589	.0442	.00164
20-30	27.6	20.6	15.0	38.9	16.5	30.8	.00476	.00509	.0354	.00146
36-46	26.7	16.3	14.7	40.3	15.2	31.9	.00519	.00659	.0341	.00130

FACEVILLE I

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	% SiO_2	% Fe_2O_3	% Al_2O_3	% TiO_2	% Ca	% Mg	% K
7-12	10.1	19.5	14.6	40.6	17.8	29.0	.00880	.00615	.0412	.00191
18-30	29.1	20.3	15.0	37.1	19.1	30.1	.00896	.00704	.0357	.00198
60-68	28.4	21.1	14.8	38.2	20.2	29.5	.00627	.00656	.0390	.00132

FACEVILLE II

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	% SiO_2	% Fe_2O_3	% Al_2O_3	% TiO_2	% Ca	% Mg	% K
7-11	8.4	17.8	13.4	38.5	22.6	25.8	.00379	n.d.*	n.d.*	.00135
20-30	31.7	17.7	14.3	38.3	21.9	27.6	.00460	.00163	.0065	.00134
44-52	30.3	14.3	13.7	40.6	20.9	25.7	.00519	.00174	.0060	.00161

*Not detected

APPENDIX TABLE 2 (continued)

MAGNOLIA I

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	% SiO_2	% Fe_2O_3	% Al_2O_3	% TiO_2	% Ca	% Mg	% K
6-11	5.6	20.9	14.9	37.4	18.7	27.2	.00615	.00465	.0353	.00133
25-39	26.5	19.3	14.7	35.3	20.1	30.4	.00948	.00442	.0275	.00133
49-55	35.3	14.9	14.2	36.4	19.1	30.0	.01004	.00569	.0339	.00085

MAGNOLIA II

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	% SiO_2	% Fe_2O_3	% Al_2O_3	% TiO_2	% Ca	% Mg	% K
3-9	4.6	25.1	12.6	41.1	23.2	24.0	.00579	.00558	.0256	.00393
20-26	32.7	19.4	13.6	37.8	25.3	25.6	.00533	.00568	.0228	.00274
38-50	25.8	21.0	13.2	38.4	27.5	21.4	.00535	.00561	.0207	.00242

[illegible] I

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	% SiO_2	% Fe_2O_3	% Al_2O_3	% TiO_2	% Ca	% Mg	% K
5-10	10.9	20.0	14.3	39.7	19.7	29.8	.00376	.00521	.0356	.00196
20-30	30.8	18.0	14.4	38.7	[illegible]	28.1	.00313	.00548	.0365	.00148
72-78	31.5	14.4	13.2	40.9	24.0	25.3	.00235	.00563	.0287	.00116

APPENDIX TABLE 2 (continued)

[redacted]

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	%SiO$_2$	%Fe$_2$O$_3$	%Al$_2$O$_3$	%TiO$_2$	% Ca	% Mg	% K
6-9	5.9	20.5	14.0	39.1	16.9	30.2	.00397	.00486	.0366	.00316
[redacted]	29.5	15.0	13.6	39.5	18.2	30.6	.00196	.00422	.0301	.00262
60-72	30.7	14.7	13.5	40.5	19.7	28.5	.00309	.00453	.0319	.00185

GREENVILLE III

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	%SiO$_2$	%Fe$_2$O$_3$	%Al$_2$O$_3$	%TiO$_2$	% Ca	% Mg	% K
6-12	25.7	15.7	16.4	32.9	18.7	31.2	.00256		.0044	.00097
22-30	28.4	14.1	16.9	29.7	18.6	24.6	.00359	.00030	.0032	.00090
60-72	21.5	15.0	16.8	31.3	18.0	27.9	.00275	.00167	.0080	.00166

GREENVILLE IV

Depth In.	% Clay	Exch. Cap.	% Loss on Ignition	%SiO$_2$	%Fe$_2$O$_3$	%Al$_2$O$_3$	%TiO$_2$	% Ca	% Mg	% K
3-7	8.5	19.9	12.5	38.9	23.9	25.4	.00423	.00549	.0350	.00296
23-30	28.9	17.9	12.4	40.1	24.2	24.5	.00394	.00499	.0301	.00325
64-72	26.6	16.3	12.4	39.1	27.9	23.3	.00600	.00380	.0199	.00234

APPENDIX TABLE 3

SOIL PROFILE DESCRIPTIONS

MARLBORO I SOIL PROFILE

[redacted] in the SE 1/4 of SE 1/4 of sec. 3, T. 2 N, R. 2W., Gadsden County, Florida, (approximately two miles south of overpass [redacted] of Havana on State Road 63; west of highway).

A_1 0" to 2" Grayish-brown (2.5Y 5/2), slightly sticky when wet, slightly hard when dry, medium subangular blocky, loamy sand, pH 5.27, fibrous roots present.

A_{21} 2" to 8" Grayish-brown (2.5Y 5/2), slightly sticky when wet, slightly hard when dry, medium to coarse subangular blocky, loamy sand, pH 5.25, some roots present.

A_{22} 8" to 13" Brownish-yellow (10YR 6/6) with some mottling of grayish-brown (2.5Y 5/2) in former root channels, very sticky when wet, slightly hard when dry, medium subangular blocky, sandy loam, pH 5.15.

B_1 13" to 20" Brownish-yellow (10YR 6/6), very sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.20.

B_{21} 20" to 30" Brownish-yellow (10YR 6/6), very sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.10.

B_{22} 30" to 36" Brownish-yellow (10YR 6/6) with a few fine faint mottles, very sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.07.

C_1 36" to 46" Yellow (10YR 7/8) very sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.08.

C_2 54" to 60" Yellow (10YR 7/8) with many medium prominent red mottles (2.5 YR 5/8), sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.08.

C_3 72" to 78" White (10YR 8/2) with many coarse prominent red mottles (10R 5/8), and common medium prominent brownish-yellow mottles (10YR 6/6), sticky when wet, hard when dry, sandy clay loam, pH 5.05.

Upland, Class A slope.

APPENDIX TABLE 3 (continued)

[redacted]

Located in the NE 1/4 of SE 1/4 of sec. 25, T. 2N., R. 5W., Gadsden County, Florida, (approximately one mile south of Sawdust on State Road 65).

A_1 0" to 7" Dark grayish-brown (10YR 4/2) nonsticky when wet, soft when dry, medium to coarse subangular blocky, loamy sand, pH 5.55, some fibrous roots present.

A_2 7" to 12" Brown (7.5 YR 5/4) with many coarse prominent dark grayish-brown mottles (10YR 4/2), sticky when wet, slightly hard when dry, mottles soft when wet, medium to coarse subangular blocky, loamy sand, pH 5.65.

B_1 12" to 18" Yellowish-red (5YR 5/6) (few prominent dark streaks in root channels), sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.55.

B_{21} 18" to 30" Yellowish-red (5YR 5/6) sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.55.

B_{22} 30" to 36" Red (2.5YR 5/6) sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.45.

B_{23} 36" [redacted] Red (2.5YR 5/6) slightly sticky when wet, slightly hard when dry, coarse subangular blocky, sandy clay loam, pH 5.59.

B_3 42" to 50" Yellowish-red (5YR 5/6) slightly sticky [redacted] wet, slightly [redacted] hard when dry, coarse subangular blocky, sandy clay loam, pH 5.40.

B_3 50" to 60" Yellowish-red (YR 5/6) slightly sticky when wet, slightly hard when dry, coarse subangular blocky, sandy clay loam, pH 5.45.

C_1 60" to 68" Strong brown (7.5YR 5/8) slightly sticky when wet, slightly hard to hard when dry, coarse subangular blocky, sandy clay loam, pH 5.45.

C_2 72" to 82" Reddish-yellow (7.5YR 6/8) slightly sticky when wet, slightly hard to hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.50.

Upland, Class A slope.

APPENDIX TABLE 3 (continued)

[redacted]

Located in the SE 1/4 of SW 1/4 of sec. 21 T. 4 N., R. 13 W., Washington County, Florida, (approximately 1-1/2 miles south of Crew on State Road, then approximately one mile east on graded road).

A_{11} 0" to 1" Brown (10YR 5/3), slightly sticky when wet, soft when dry, medium crumb structure, sand, pH 5.53, fibrous roots present.

A_{12} 1" to 7" Brown (10YR 5/3), slightly sticky when wet, soft when dry, coarse subangular blocky, sand, pH 5.40, fibrous roots.

A_2 7" to 11" Yellowish-brown (10YR 5/4), slightly sticky when wet, soft when dry, coarse subangular blocky, loamy sand, pH 5.30.

B_1 11" to 20" Yellowish-brown (10YR 5/6), slightly hard when dry, coarse subangular blocky, sandy clay loam, pH 5.07.

B_{21} 20" to 30" Strong brown (7.5YR 5/6), sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 4.82.

B_{22} 30" to 38" Reddish-yellow (7.5YR 6/6), sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.05.

B_{23} 38" to 44" Reddish-yellow (7.5YR 6/6) sticky when wet, slightly hard when dry, medium subangular blocky, sandy clay loam, pH 4.77.

C_1 44" to 52" Reddish-yellow (7.5 YR 6/6) with some light grayish-brown mottling (10YR 6/2), sticky when wet, slightly hard when dry, medium subangular blocky, sandy clay loam, pH 4.87.

C_2 52" to 56" Reddish-yellow (7.5YR 6/6) with common medium prominent red mottles (10R 4/8) and few fine prominent white mottles (10YR 8/1) and few coarse distinct pale brown mottles (10YR 6/3), sticky when wet, slightly hard to hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 4.83.

C_3 56" to 64" Reddish-yellow (7.5YR 6/6) with coarse prominent white mottles (10YR 8/1) and common medium distinct red mottles (10R 5/6), sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.03.

APPENDIX TABLE 3 (continued)

C_4 77" to 81" Red (2.5YR 4/8) with many coarse prominent white mottles (10YR 8/1) and strong brown mottles (7.5YR 5/6), sticky when wet, hard when dry, medium subangular blocky, clay, pH 4.95.

Upland, Class C slope.

APPENDIX TABLE 3 (continued)

MAGNOLIA I SOIL PROFILE

Located in the NE 1/4 of NE 1/4 of sec. 30, T. 2 N., R. 2 W., Gadsden County, Florida (approximately one mile east of Sawdust on unnumbered road).

A_1 0" to 6" Dark greyish-brown (10YR 4/2) slightly sticky when wet, soft when dry, fine to medium subangular blocky, light loamy sand, pH 5.47, fibrous roots present, many stones.

A_2 6" to 11" Yellowish-brown (10YR 5/4) slightly sticky when wet, slightly hard when dry, fine to medium subangular blocky, loamy sand, pH 5.55.

A_3 11" to 14" Yellowish-red (5YR 5/6) sticky when wet, slightly hard when dry, medium subangular blocky, loamy sand, pH 5.45.

B_1 14" to 25" Yellowish-red (5YR 5/8) sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.42.

B_2 25" to 39" Red (2.5YR 5/8) sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.30.

B_2 39" to 48" Red (2.5YR 5/8) with common medium prominent yellow mottles (10YR 7/6), very sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 4.85.

C_1 48" to 55" Red (2.5YR 5/8) with common medium prominent yellow mottles (10YR 7/6), very sticky when wet, hard when dry, medium subangular blocky, sandy clay, pH 4.98.

C_2 55" to 64" Light red (2.5YR 6/8) with many coarse prominent yellow mottles (2.5Y 8/6), very sticky when wet, hard when dry, medium subangular blocky, sandy clay, pH 4.95.

C_3 64" to 72" Light red (2.5YR 6/8) with many coarse prominent white mottles (10YR 8/2), very sticky when wet, hard when dry, medium subangular blocky, sandy clay, pH 5.42.

Upland, Class B slope.

APPENDIX TABLE 3 (continued)

MAGNOLIA IX SOIL PROFILE

Located in the NE 1/4 of the SW 1/4 of sec. 16, T. 4 N., R. 7 W., Jackson County, Florida (approximately 2-1/2 miles north of Sneads on the west side of a graded road).

A_1 0" to 3" Dark grayish-brown (10YR 4/2), nonsticky when wet, slightly hard when dry, medium granular structure, heavy sand texture, pH 5.89, grass roots present.

A_2 3" to 9" Dark yellowish-brown (10YR 4/4), nonsticky when wet, soft when dry, medium granular structure, loamy sand texture, pH 5.79, some roots present.

B_1 9" to 20" Dark red (10R 3/6), sticky when wet, hard when dry, subangular blocky structure, sandy clay loam texture, pH 5.25, some roots present.

B_{21} 20" to 26" Dark red (10R 4/6), sticky when wet, hard when dry, subangular blocky structure, sandy clay loam texture, pH 5.45, few roots present.

B_{22} 26" to 38" Dark red (10R 3/8), sticky when wet, hard when dry, subangular blocky structure, sandy clay loam texture, pH 5.36.

C_1 38" to 50" Dark red (10R 3/8), sticky when wet, slightly hard when dry, subangular blocky structure, sandy clay loam texture, pH 5.60.

C_2 50" to 60" Dark red (10R 3/8), slightly sticky to sticky when wet, hard when dry, subangular blocky, sandy clay loam texture, pH 5.59.

C_3 60" to 70" Red (10R 4/8), slightly sticky to sticky when wet, slightly hard, subangular blocky structure, sandy clay loam texture, pH 5.23.

C_4 70" to 80" Red (10R 4/8) with medium size brownish-yellow mottles (10YR 4/8), slightly sticky when wet, sandy clay loam texture, pH 5.17.

Upland, Class C slope.

APPENDIX TABLE 3 (continued)

GREENVILLE I SOIL PROFILE

Located in the NE 1/4 of the NE 1/4 of sec. 1, T. 2N., R. 4W., Gadsden County, Florida (approximately two miles north of the center of Quincy on road between State Highways 65 and 268) on east side of road.

A_1 0" to 5" Dark reddish-brown (5YR 3/2) slightly sticky when wet, slightly hard when dry, medium subangular blocky, loamy sand, pH 6.32, some fibrous roots present.

A_2 5" to 10" Dark red (2.5YR 3/4) with streaks of yellowish-red (5YR 3/3) in former root channels, slightly sticky when wet, slightly hard when dry, medium to coarse subangular blocky, light sandy loam, pH 6.04, fibrous roots present.

B_1 10" to 14" Dark red (10R 3/6), sticky when wet, hard when dry, medium to coarse angular blocky, sandy clay loam, pH 5.92.

B_{21} 14" to 20" Dark red (10R 3/8), sticky when wet, hard when dry, medium to coarse angular blocky, sandy clay loam, pH 5.38.

B_{22} 20" to 30" Dark red (10R 3/8), sticky when wet, hard when dry, medium to coarse angular blocky, sandy clay loam, pH 5.28.

B_{23} 30" to 36" Red (10R 4/8) sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.28.

B_{24} 36" to 44" Red (10R 4/8) slightly sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.22.

B_3 44" to 50" Red (10R 4/8) slightly sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.15.

C_1 50" to 60" Red (10R 4/8) slightly sticky to sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 5.22.

C_2 72" to 78" Red (10R 4/6) with medium common prominent white mottles (10YR 8/2), slightly sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.22.

Upland, Class B slope.

APPENDIX TABLE 3 (continued)

[redacted]

Located in the SE 1/4 of the SE 1/4 of sec. 6, T. 6 N., R 11 W., Jackson County, Florida (approximately 2-1/2 miles east of Campbellton on State Road 2).

A_1 0" to 6" Reddish-brown (5YR 4/4), slightly sticky when wet, slightly hard when dry, medium subangular blocky, loamy sand, pH 6.55, some clover roots and peanut hulls present.

A_2 6" to 9" Reddish-brown (5YR 4/4), slightly sticky when wet, hard when dry, medium subangular blocky, loamy sand, pH 6.61, some fibrous roots, peanut hulls.

B_1 9" to 18" Red (2.5YR 4/6), sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 6.06, some fibrous roots.

B_{21} 18" to 28" Red (2.5YR 4/8), sticky when wet, hard when dry, medium subangular blocky, sandy clay loam, pH 6.00, few fibrous roots.

B_{22} 28" to 38" Red (2.5YR 4/8), sticky when wet, hard when dry, fine to medium subangular blocky, sandy clay loam, pH 5.45.

B_{23} 38" to 48" Red (10R 4/8), sticky when wet, hard when dry, fine to medium subangular blocky, sandy clay loam, pH 5.38.

B_{24} 48" to 60" Red (10R 4/8), sticky when wet, hard when dry, fine to medium subangular blocky, sandy clay loam, pH 5.35.

C 60" to 72" Red (10R 4/8), sticky when wet, slightly hard when dry, fine to medium subangular blocky, sandy clay loam, pH 5.02.

Upland, Class B slope.

APPENDIX TABLE 3 (continued)

GREENVILLE III SOIL PROFILE

Located in the SW 1/4 of the NW 1/4 of sec. 26., T. 5 N., R. 10 W., Jackson County, Florida (approximately 1/4 mile north of Florida Caverns State Park on State Road 167).

A_1 0" to 6" Dark reddish-brown (5YR 3/4), slightly sticky when wet, slightly hard when dry, coarse subangular blocky, sandy loam texture, pH 5.79, some grass roots present.

A 6" to 12" Dark red (2.5 YR 3/6), sticky when wet, slightly hard when dry, medium to coarse subangular blocky, sandy clay loam, some roots present, pH 5.62.

B_{21} 12" to 22" Dark red (10R 3/6), sticky when wet, slightly hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.38.

B_{22} 22" to 30" Dark red (10R 3/6), sticky when wet, slightly hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.25.

B_{23} 30" to 38" Dark red (10R 3/6), slightly sticky when wet, slightly hard when dry, medium to coarse subangular blocky, sandy clay loam, pH 5.35.

B_{24} 38" to 48" Dark red (10R 3/6), slightly sticky when wet, slightly hard when dry, medium subangular blocky, sandy clay loam, pH 5.55.

B_{25} 48" to 60" Dark red (10R 3/8), slightly sticky when wet, slightly hard when dry, medium subangular blocky, sandy clay loam, pH 5.62.

C_1 60" to 72" Dark red (10R 3/8), slightly sticky when wet, slightly hard when dry, medium subangular blocky, sandy clay loam, pH 5.60.

C_2 72" to 76" Dark red (10R 3/8), slightly sticky when wet, slightly hard when dry, medium subangular blocky, sandy clay loam, pH 5.47.

Upland, Class B slope.

APPENDIX TABLE 3 (continued)

GREENVILLE IV SOIL PROFILE

Located in the NE 1/4 of the NE 1/4 of sec. 18, T. 5 N., R. 10 W., Jackson County, Florida (approximately 4.6 miles north of Marianna on graded road between State Roads 73 and 167).

A_1 0" to 3" Dark reddish-brown (5YR 3/4), nonsticky when wet, soft when dry, medium subangular blocky, light loamy sand texture, pH 6.11.

A_2 3" to 7" Dark reddish brown (2.5YR 3/4), slightly sticky when wet, soft when dry, medium subangular blocky, heavy loamy sand texture, pH 6.23.

B_{11} 7" to 14" Red (2.5YR 4/8), sticky when wet, slightly hard when dry, coarse subangular blocky, sandy loam texture, pH 5.52.

B_{12} 14" to 23" Red (2.5YR 4/8), sticky when wet, hard when dry, coarse subangular blocky, sandy clay loam texture, pH 5.15.

B_{21} 23" to 30" Red (2.5YR 4/8), sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam texture pH 5.12.

B_{22} 30" to 40" Red (2.5YR 4/8), sticky when wet, hard when dry, medium to coarse subangular blocky, sandy clay loam texture, pH 4.88.

B_{23} 40" to 48" Red (2.5YR 4/8), sticky when wet, hard when dry, medium subangular blocky, sandy clay loam texture, pH 5.12.

B_{24} 48" to 56" Red (2.5YR 4/8), sticky when wet, hard when dry, fine to medium subangular blocky, sandy clay loam texture, pH 5.06.

B_3 56" to 64" Red (2.5YR 4/8), sticky when wet, hard when dry, medium subangular blocky, sandy clay loam texture, pH 4.90.

C_1 64" to 72" Red (2.5YR 4/8), sticky when wet, hard when dry, medium subangular blocky, sandy clay loam texture, pH 4.88.

C_2 80" to 86" Red (2.5YR 4/8), with common medium prominent very pale brown mottles (10YR 8/6), sticky when wet, hard when dry, medium subangular blocky, sandy clay loam texture, pH 5.06.

Upland, Class B slope.

BIOGRAPHICAL NOTE

Charles L. Dantzman was born November 1, 1917, in St. John, Kansas. He served as a member of the U. S. Army Air Force from November, 1942, until January, 1946, during which time he attended an Army Administration School at Mississippi Southern College and later worked in that capacity first in the Ordnance and then in Classification and Personnel.

In August, 1949, he entered the University of Georgia at Athens, where he majored in Botany and minored in Animal Husbandry and Geology-Geography. He received the Degree of Bachelor of Science in Agriculture in December, 1952. In June, 1955 he received the Degree of Master of Agriculture at the University of Florida with a major in Soils and a minor in Agronomy. He then continued graduate study at the University of Florida and obtained the Doctor of Philosophy Degree in January, 1960 with a major in Soils and minors in Plant Ecology and Geology.

He is a member of Phi Kappa Phi, Phi Sigma, and Gamma Sigma Delta Fraternities.

This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of the committee. It was submitted to the Dean of the College of Agriculture and to the Graduate Council, and was approved as partial fulfillment of the requirements for the Doctor of Philosophy Degree.

January, 1960

M. A. Brooker
Dean, College of Agriculture

Dean, Graduate School

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